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CABBAGE PRODUCTION IN CALIFORNIA

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CLIMATIC AND SOIL REQUIREMENTS

Cabbage is a cool season crop, making its best development in those localities where it can grow to maturity under moderately humid conditions and where the temperature is cool and equable. In California cabbage does best on the coast and in the bay regions where the climate is subject to the modifying influence of large bodies of water. In these regions it grows well throughout the greater part of the year. In the interior valleys the crop is grown mainly during the fall, winter and early spring. The cool and uniformly mild weather has a tendency to hold in check the cabbage diseases that are so prevalent in the cabbage growing districts of the eastern and northern states.

SEASONS OF PRODUCTION

Cabbage is grown both for local consumption and for distant shipment. Most of the cabbage shipped in carload lots from California is moved between December and the middle of June. This brings the California crop into competition with the late crop that is kept in storage in New York and Wisconsin and with the early crop from the Southern states. By the end of March the stored product has been almost entirely moved, but Alabama, Florida, Louisiana, South Carolina and Texas ship enormous quantities north and keep the market well supplied until the middle of May or first of June. Then the early crop starts to move from Maryland, New Jersey, Ohio, Virginia, and Tennessee. During July and August, the large northern and eastern markets are being pretty well supplied by home grown produce. This home grown supply accounts largely for the falling off in carlot shipments during mid-summer. If the northern late crop is below the average, or if the southern acreage is small or the yield low, there should be a strong demand for California cabbage at a price that will make eastern shipment profitable. The heavy line in figure 1 shows the average farm price of cabbage for the United States on the 15th of each month for a period of twelve years, 1910 to 1921 inclusive. The

peak of prices is reached the latter part of May and the early part of June. This is near the end of the Florida, South Carolina and Texas shipments and before the early crop of the north is on the market. During this period, Virginia, Maryland, Mississippi and Tennessee are the heaviest shippers. It is at this time that California must put cabbage on the markets of the East if profitable returns are to be expected over a series of years.

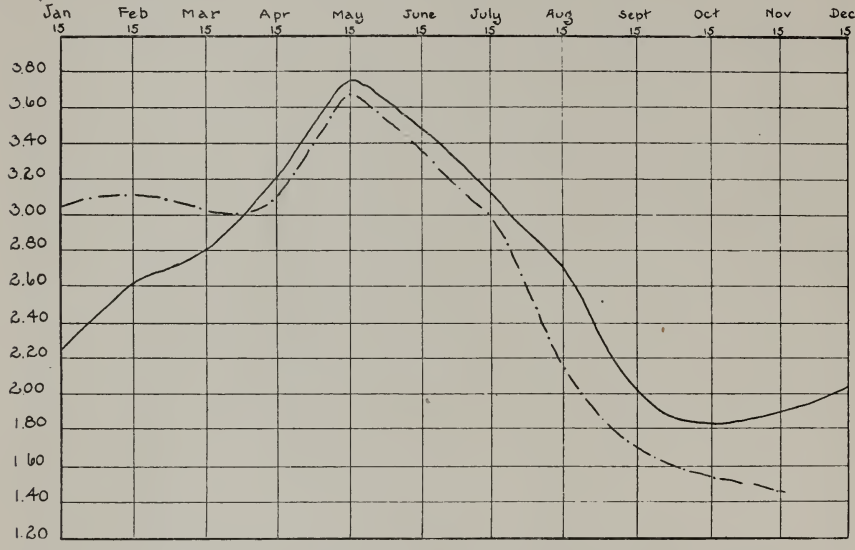

Fig. 1.—Average farm price in the United States per 100 pounds of cabbage on the 15th of each month for the years 1910–1921 inclusive, and for the months January–November, inclusive, 1922.

————————Average for years 1910–1921 inclusive.

— - — - - - —Average for the months January–November, inclusive, 1922.

(Data from *Weather, Crops and Markets,* vol. 2, no. 26, p. 570.)

In figure 2 are charted the periods of shipment of some of the more important cabbage producing states, showing the relation they bear to one another. This diagram shows the approximate range of dates that cabbage may be shipped from various districts. The shading has reference to the 1922 shipping season only, and is intended to show primarily the period of greatest movement from the various districts.

In figure 3 is plotted the total carlot shipments of the entire country. This curve shows the rapid decline in carlot shipments during the latter part of May and the month of June, a period which is also characterized by a high average price. During July and August the demand is usually taken care of by home grown supplies, which accounts for the small carlot movement during this period.

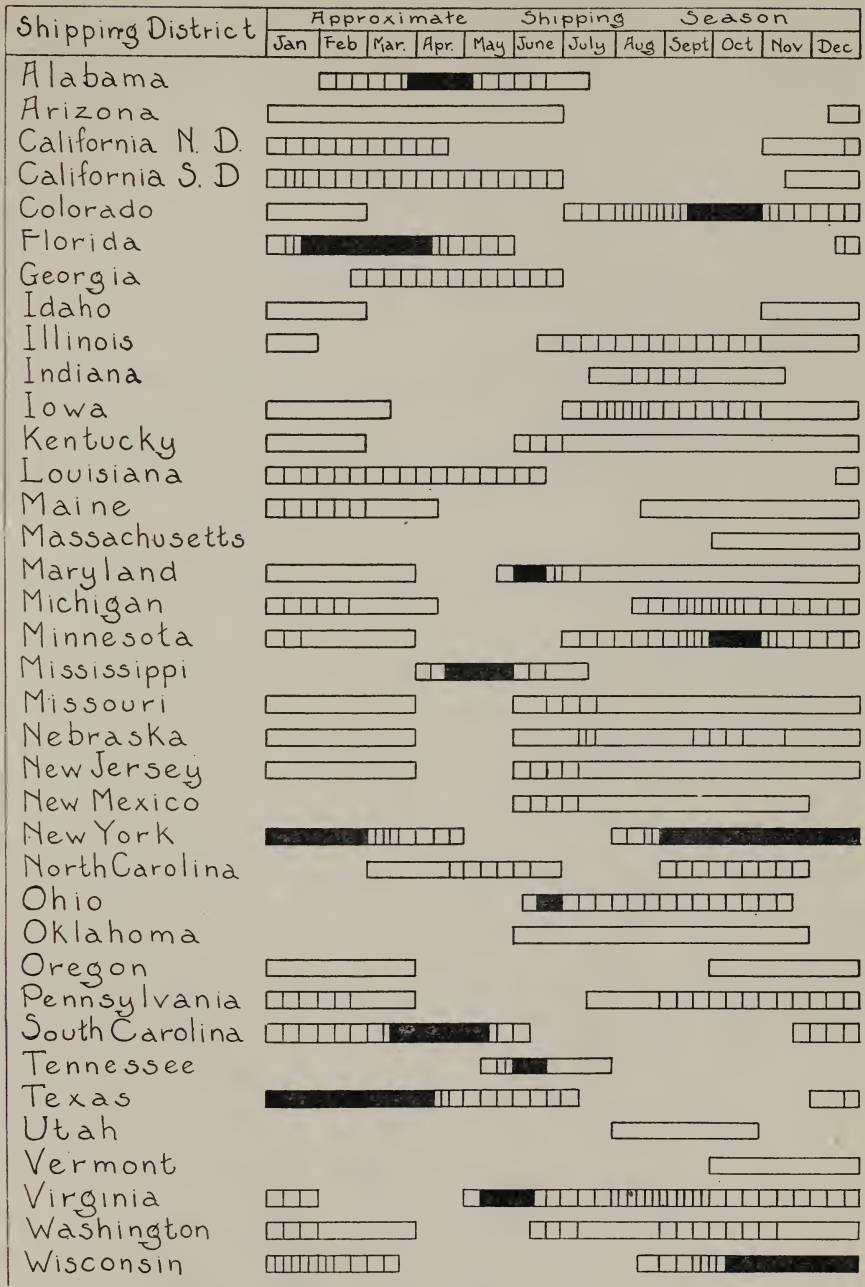

Fig. 2.—Showing the periods of shipment of some of the more important cabbage producing states and the relation they bear to one another; also the approximate range of dates that cabbage may be shipped from various districts. The shading has reference to the 1922 shipping season, only.

□ 50 cars or less per week. [|] 51-100 cars per week. ▬ 101 cars and more per week.
|——| Approximate range of dates that cabbage may be shipped.

(Data from *Weekly Summary of Carlot Shipments*, U. S. Department of Agriculture)

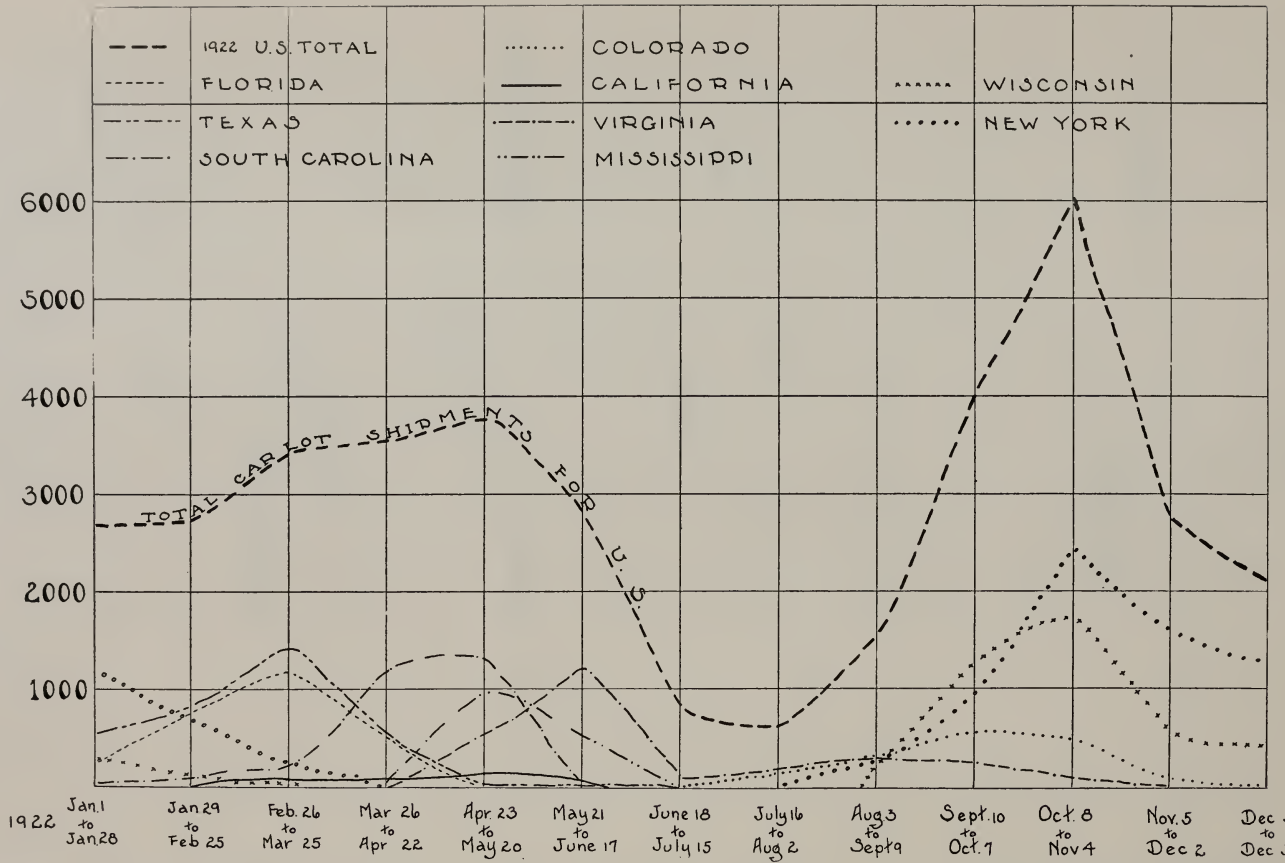

Fig. 3.—Carlot shipments of cabbage by four week periods throughout the year, showing total carlot shipments for the United States and from the main producing areas.
(Data from the *Weekly Summary of Carlot Shipments,* U. S. Department of Agriculture.)

The large cabbage growing districts are pretty well defined, the principal ones being in the northern states. The most extensive cabbage district in the United States is in the state of New York and lies between the cities of Buffalo and Syracuse. About one-fourth of the acreage of the entire country is found in this district. Other important areas of production are Long Island, around Norfolk and in Wythe County, Virginia; along Lake Michigan from Chicago to Milwaukee, between Denver and Greeley, Colorado, in Florida, in the Young Island district of South Carolina, in Copiah County, Mississippi and in the Lower Rio Grande Valley of southern Texas.

While cabbage growing in California has not reached the concentration of production that exists in some other states, nevertheless the producing areas are pretty well localized. The main districts are around the city of Los Angeles, in the Colma region south of San Francisco, and in Orange County.

SEEDING, TRANSPLANTING, AND HARVESTING SEASONS FOR VARIOUS DISTRICTS

In the Colma district south of San Francisco, cabbage is seeded, transplanted, and harvested during nearly every season of the year. A variety known as San Francisco Market, also known as Colombo Market, is grown in this district almost exclusively. It is a very distinct type, the head being flat and the leaves especially heavy veined. This variety is very hardy and is noted for its slow habit of growth. The seed is grown locally. The crop is hauled to San Francisco by truck or is shipped to the interior valleys, to Fresno, Stockton, and Sacramento. Very little is shipped to the eastern markets. Some of the surplus is made into sauerkraut.

In the Salinas Valley district of Monterey County, the date for sowing seed ranges from June to October, the plants are transplanted into the field from September to December, and the crop is harvested from February to May. In the Salinas district cabbage production is largely localized between the Salinas River Valley and the coast.

In Contra Costa County seed for the fall crop is ordinarily planted from July 1 to July 15. The crop is transplanted to the field six to seven weeks after the seed has been sown, and the crop is harvested from October 15 to January 15. The seed for the summer crop is planted from February 1 to February 15, transplanting is done seven to eight weeks after seeding and the crop is harvested from July 1 to August 31. The dwarf Flat Dutch is grown for the summer crop and Copenhagen Market for the fall crop. Practically all of the cabbage grown is disposed of in the local markets, principally in Walnut Creek, Concord, Martinez, and Pittsburg.

In San Diego County, seed is sown from June 15 to August 1 and plants set in the field July 15 to September 1. The chief varieties planted are Danish Ballhead and Winningstadt. A portion of the crop is marketed locally and carlot shipments go to Arizona, Utah, Washington and other parts of the west. Between 300 and 400 acres of cabbage are grown in San Diego County each year and production is concentrated mainly in the El Cajon, San Luis Rey, San Diego, and Tia Juana valleys.

In Ventura County, seed can be planted at almost any time of the year and the same can be said of transplanting into the field. The variety usually planted is Winningstadt. The crop can be brought to maturity at any time of the year. Most of the crop goes to Los Angeles. Growing is largely localized about Oxnard near the ocean. The area in Ventura County ranges from 80 to 100 acres.

In San Bernardino County cabbage production is primarily for the local markets, the surplus going to Los Angeles. There is probably more cabbage imported into the county than is shipped out. The best results are had by sowing seed about July 15 and transplanted into the field early in September. The crop is harvested during December and January. The common varieties are Winningstadt and Danish Ballhead.

A considerable acreage of cabbage is grown in Orange County. Seed is generally sown the latter part of August and during September and October. Transplanting is generally done in the latter part of September, October and the first part of November. The crop is harvested during December, January and February. The varieties chiefly grown are Winningstadt, Flat Dutch, and Cannonball. The principal centers of production in Orange County are at Buena Park, Stanton and Irvine.

Cabbage production in Sonoma County is largely localized about the city of Santa Rosa. The plantings in the county approximate 90 acres. The local markets and San Francisco take most of the crop. The Early York variety is grown for the early spring crop, maturing in May. Early Flat Dutch is harvested in June following Early York, while Late Flat Dutch is harvested in October, November and December.

In Santa Cruz County, seeding and transplanting can be done at almost any time of the year. The harvesting season extends throughout the entire year. For the summer crop, however, the transplanting is done in December and for the winter crop, in August. The principal varieties planted are Early Flat Dutch, Sugar Loaf, Copenhagen Market, Early Jersey Wakefield, Late Flat Dutch, and Danish Ballhead.

In San Joaquin County, the cabbage is mostly localized within a radius of ten miles of Stockton. Some of the crop is sold for sauerkraut manufacture, some shipped to San Francisco, but most of the crop is sold in Fresno, Stockton, and other San Joaquin Valley towns. The varieties principally grown are Early Flat Dutch, Late Flat Dutch, and Drumhead. Seed for late crop is sown in August and September and the plants are set in the field in September and October. The late crop is harvested from December to February. The early crop is harvested from March to May.

Only a small acreage of cabbage is grown in Tehama County. For the early crop seed is usually sown in hot-beds in December. Transplanting into the field when the plants are about six weeks old brings the crop to maturity during May and June. The varieties grown are the Copenhagen Market and Early Flat Dutch.

In Los Angeles County a considerable tonnage of cabbage is shipped throughout the winter, spring and early summer. At present a large portion of the cabbage shipped from Los Angeles County is in cars of mixed vegetables, so it does not show up in the carlot movements. The Winningstadt is the favorite shipping cabbage; the Flat Dutch, Danish Ballhead, and Copenhagen Market varieties are grown for the home trade.

In the Imperial Valley, cabbage can be grown during the late fall, winter and early spring. The seed should be sown early enough for the plants to be set out in the field during October or November. The crop is harvested from February to May. Aphis infestations are especially severe in this county.

VARIETIES

It is very important that a variety be selected for planting that grows and produces well in the locality under consideration and at the same time satisfies the demand of the market to which the district caters. Attention must be given to the selection of varieties and strains that are well suited to climatic conditions and to the market demands.

Winningstadt.—This variety is at present the one most extensively grown in southern California, and probably is the favorite variety among the shippers. It has an excellent dark green color and is of the proper size to pack well. It is a solid heading, sharply pointed cabbage and is more resistant to insect and disease attacks and more tolerant to variations in climatic conditions than many other varieties.

Scott's Cross.—This is a variety of recent introduction that is being given a trial by a number of growers in the Los Angeles district. The variety is said to be a cross between Winningstadt and Flat Dutch. It is a heavier yielder than Winningstadt and apparently tolerates considerable cold and checking in growth without injuring its ability to head.

Some strains of Scott's Cross have in the past lacked uniformity which has been one of the chief objections heretofore to this variety. One of the great problems of the grower in southern California is to prevent cabbage from going to seed instead of forming a head. The introduction of a variety or strain that will not have a tendency to go to seed after being checked by unfavorable weather will be a great asset to the growers.

Fig. 4.—Late Flat Dutch cabbage. Specimen at the right shows growth habit of the entire plant. Same plant at the left with near leaves removed to show head type.

Early Jersey Wakefield.—The head of Jersey Wakefield is sharply pointed. It has a very small head, and except where extreme earliness is essential the Charleston Wakefield or Copenhagen Market is preferred. It does not hold up long after maturity. It is an excellent variety for the home garden but is not grown extensively in California.

Late Flat Dutch.—Also known as Premium Flat Dutch and Premium Late Flat Dutch. The head is large and considerably flattened. A late maturing variety but exceptionally heavy producer; not suited for shipment because of tendency to grow over-sized; a good type of Late Flat Dutch is shown in figure 4.

Copenhagen Market.—The Copenhagen Market cabbage is of Danish origin and was first introduced into the United States in 1912. No cabbage introduced in recent years has had the popular

reception accorded this variety and it is being planted extensively as a truck crop, market garden crop, and in the home garden. The head is nearly round, solid, and matures at approximately the same time as the Charleston Wakefield.

Early Flat Dutch.—This is one of the oldest varieties grown in this country having been listed by seedsmen as early as 1847. It is a short stemmed variety and has very few outer leaves. It is grown largely in central California as a late winter and early spring crop.

Danish Ballhead or Hollander.—This is a late variety and is the one most commonly grown for storage purposes. The head is nearly round, solid, of good quality and of a bluish green color.

The shipping and market term "Danish type" refers to all those varieties with hard smooth heads with oval, round or slightly flat shape, and with smooth, tight, broadly overlapping leaves, such as Danish Ballhead and Cannonball.

GROWING PLANTS

Plants may be raised in hot beds, cold frames or in open beds. The locality and the time of the year that the seed is sown will determine the method to be used.

Growing Plants in Hot Beds.—When plants are started during the cold winter months it is often an advantage to sow the seed in hot beds. The beds should be located where they will be protected from the prevailing winds, have an abundance of sunlight and where good natural drainage is afforded. They should be situated so as to have a ready supply of water available. Figure 5 (above) shows the cross section of a hot bed with dimensions and method of filling. The bottom of the pit is 22 inches below the ground line. The north side of the frame should be at least six inches higher than the south side. Figure 5 (below) shows top view of hot bed with dimensions and methods of construction.

Fresh horse manure should be spread uniformly in a compact pile. When heating starts the manure should be placed in the beds. That portion of the pile heating most violently should be placed at the bottom of the bed and that which has not yet started to heat should be placed near the top. Each three or four inches of manure added should be well tramped so as to have the entire mass uniformly packed. It is well to add a bucket or two of water to each bed so as to prevent burning during fermentation. About 4 inches of soil should now be spread over the manure. A sandy loam that is free

from large clods and stones, or else sieved through a screen with about one-quarter inch mesh is best. Within a day or two after placing the manure in the beds it will heat violently but the heating will subside in another day or two. Seed should not be planted until after the first violent heat is over. When the temperature has receded to 85–80° F. the seed can be planted. It is best to plant the seed in rows three to four inches apart and one-quarter to one-half inch

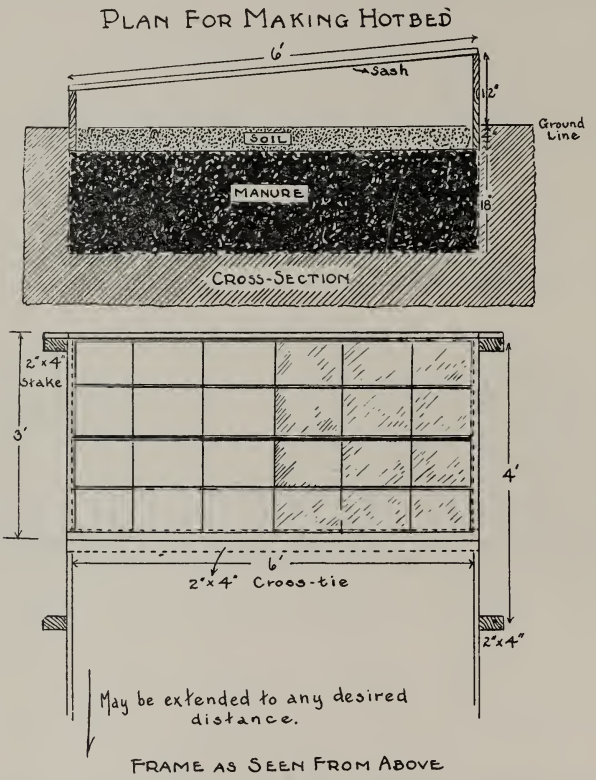

Fig. 5.—Above. Cross section of hot bed showing method of construction and filling. Below. Top view of cold frame or hot bed, with dimensions and method of construction.

deep. Seed should be scattered thinly in the row as this guards against a weak, leggy plant and lowers the seedling mortality. After seeds are covered the soil should be tramped or rolled to insure rapid and uniform germination. After watering the bed should be covered and left until the seedlings are just breaking through the soil. Then give plenty of sunlight and ventilation. A too high temperature at this time is liable to produce a leggy, weak plant, subject to damping-off. Too rapid growth at this time also causes

the plant to lodge, developing a crooked stem and making transplanting difficult. Watering should be done only on bright mornings so that the soil surface will soon dry. Water thoroughly but not too often.

The hot beds may be covered with any material that will hold the heat in the bed and protect the bed from beating rains. Glass sash, tules or muslin may be used. A medium weight muslin is much cheaper than glass and seems to give satisfaction in most sections of California. The coverings of the beds should be removed during warm days and entirely removed a week or ten days before the plants are set out in the field, in order to harden them and make them better able to withstand the range of temperature and humidity conditions to which they will be exposed in the field. Water should be withheld to some extent the last week or ten days before transplanting, as this also helps to harden the plants and makes them better able to withstand the shock of transplanting. The plants should be well watered before they are pulled, so as to have as much dirt as possible adhere to the roots, and removed from the beds carefully, so as to preserve as many of the small fibrous roots as possible. On the right in figure 6, is a plant that has been properly removed. At this time the large outer leaves should be pinched back. This latter practice is especially desirable if transplanting takes place during the season of the year when the days are hot and when the relative humidity is low.

Growing plants in cold frames.—The cold frame is much more commonly used in California for growing early cabbage plants than is the hot bed. In most sections, even in northern California, the weather is so mild that cabbage plants can be started if the frames are located in a protected place and covered with glass or muslin. The plants grown in cold frames are usually more vigorous, stockier and hardier than hot bed grown plants. The cold frame is made like the hot bed except that no excavation or pit is dug. The frame rests directly on the surface of the ground. Figure 5 shows top view of cold frame with dimensions and method of construction. The seed will be a little slower to germinate in the cold frame than in the hot bed and it will take a little longer for the plant to reach the transplanting stage.

Growing plants in open beds.—In many sections of California the plants are grown in open beds. If the plants are grown during the summer the seed is often drilled in beds in the open field. If grown during the fall, winter or spring, the seed bed is located in a more or less protected place. If the seed bed is subjected to

baking, the hard crust may prevent the seedlings from coming through. A covering of straw or burlap sacks may be placed over the beds, but should be removed as soon as the seedlings break through the soil.

The time required for plants to reach the transplanting age varies with the time of the year. During the cooler portion of the year eight to nine weeks is usually sufficient if plants are grown in cold

Fig. 6.—As many small roots as possible should be preserved when transplanting. Plant on the right has been properly removed.

frames or open beds. If the plants are grown during the warm part of the year or in hot beds a much shorter time, approximately six weeks, will bring the plants to the proper size. An effort should be made to grow the plants in such a manner as to have a uniform, continuous growth. Stunting plants in the seed bed is often one of the chief reasons for poor heading and crop failure. In some parts of the state the plants are allowed to remain in the crowded

seed bed for a period of twelve to fifteen weeks. The plants then become badly stunted, the stems become woody, the lower leaves turn yellow and drop off. This retarding and checking of growth for such a long period may contribute somewhat to the trouble of premature seeding often experienced.

FIELD PLANTING AND CULTURE

Soil.—Cabbage will adapt itself to a wide range of soil types. Large acreages are grown on muck, clay loam and sandy loam soils. The earliest cabbage is grown on the lighter types of soil that warm

Fig. 7.—Cabbages when transplanted are placed on the edges of the furrows.

up rapidly in the spring. The heaviest corps are produced, however, on the heavier soils. The cabbage crop is a strong feeder and should therefore be given liberal fertilization. An application of ten to twenty tons per acre of well rotted barnyard manure will usually be found profitable. Commercial fertilizer should be applied providing barnyard manure cannot be obtained at a reasonable cost. The amount and mixture to apply depends upon the original fertility of the soil. An occasional dressing of nitrate of soda at the rate of 50 to 100 pounds per acre will keep the crop growing and give it a dark green color. It is almost impossible to lay down rules for fertilizer applications that will hold for the entire state, or even for any large

district within the state. The grower should make a number of fertilizer tests on his own farm and determine the most profitable amount to apply and the best formula to use.

The plants are usually set on the edge of ridges or beds, if planted during the dry part of the year. Figure 7 shows the method of planting prevalent in most sections of the state. The number of plants required to plant an acre can be determined by multiplying the distance in feet between plants in the row, by the distance between rows, and dividing this product into 43,560, which is the number of square feet in one acre. Small acreages are usually planted by hand by the use of dibbles, trowels, spades or the "scandigie," while large acreages are set with the aid of horse drawn transplanters. The distance between plants varies with the variety. Large heads are not especially desirable for shipping purposes and when the larger types are planted for shipping they should be crowded somewhat so that a smaller head will be produced.

The cabbage crop responds to good cultivation; it will not tolerate neglect like some of our other garden and truck crops. Cultivation should be thorough and frequent. Everything possible in the way of tillage, regulation of water supply and fertilization should be done to keep the plants in a healthy growing condition, and development should not be severely checked at any time.

If cabbage plants are stunted during the winter by extremely cold weather, or by not receiving the proper attention as to watering and cultivation, an unusually large percentage will shoot to seed when the weather turns warm in the spring. Conditions that favor a uniform and steady growth throughout the winter are conducive to good head formation and low percentage of flower development. The variety or strain also has a great deal to do with this tendency to shoot to seed stalks. Experiments at the Virginia Truck Experiment Station show a great difference between strains of Early Jersey Wakefield in percentage of plants forming seed stalks prematurely. Bulletins 37 and 38 of the above station state, "Indications are that certain inherent tendencies in the seed itself contribute to this condition . . . In the four earliest lots of Early Jersey Wakefield an average of 10.9 per cent of the plants went to seed as compared with 21.7 per cent in the four latest heading lots. This correlation between early uniform heading and a low percentage of seed stalks has been frequently noted in the commercial fields. The plants which form a small compact head early in the season are less likely to seed prematurely than those which are somewhat open headed and leafy."

HARVESTING AND GRADING

Growers and shippers should take great care in harvesting and grading their product. Rough handling in harvesting and packing will cause bruises that facilitate the entrance of disease that may cause much loss to the shipper. In shipping a tight pack is also very important. Cabbage shrinks somewhat due to loss of water. The crate should be well packed and given a good bulge to take care of shrinkage in transit. Heads packed tightly are less liable to bruise and injury than when free to move within the crates. Rigid grading is of utmost importance to the California shipper. It is only by placing a superior product on the markets of the Eastern, Central and Middle Western states that we can hope to compete with the districts nearer the large consuming centers. Standard grades are being established to serve as a guide for growers and packers in the grading of their produce and to aid state and federal inspection at the point of shipment and upon arrival at destination.

The United States grades for cabbage as formulated by experts of the Bureau of Agricultural Economics of the United States Department of Agriculture, issued on February 16, 1922, are as follows:

U. S. NO. 1

U. S. No. 1 shall consist of heads of cabbage which are of one type, fairly firm and well trimmed; which are not soft, withered, puffy or burst; which are free from soft rot, seed stems and from damage caused by discoloration, freezing, disease, insects, or mechanical or other means.

In order to allow for variations incident to proper grading and handling, not more than 10 per cent, by weight, of any lot may be below the requirements of this grade.

Any lot of cabbage consisting of heads of more than one type but which meet all other requirements of U. S. No. 1 may be designated U. S. No. 1 Mixed.

U. S. NO. 2

U. S. No. 2 shall consist of heads of cabbage which do not meet the requirements of the foregoing grade.

SIZE

In addition to the statement of grade, any lot may be classified as Small, Medium, Large, Small to Medium, or Medium to Large,

if 75 per cent, by weight, of the heads conform to the following requirements for such sizes:

	Small	*Medium*	*Large*
Pointed	Under 2 lbs.	2 to 4 lbs., inclusive	Over 4 lbs.
Other types	Under 4 lbs.	4 to 6 lbs., inclusive	Over 6 lbs.

DEFINITION OF TERMS

As used in these grades:

"One type" means that all the lot is Pointed, Danish, Domestic, Savoy or Red, as the case may be. Pointed type includes such varieties as Early Jersey Wakefield, Charleston Wakefield, Early York, Winningstadt, and others which normally develop oblong, conical or pointed shaped heads. Danish type includes such late maturing varieties as Danish Ballhead or Hollander and Danish Roundhead, which normally develop hard, tightleaved, compactly formed heads. A head of any such variety even after trimming will appear tight and smooth-leaved around the basal portion and when viewed from the stem end, circular and regular in outline. Domestic type includes such varieties as Succession, All Head Early Flat Dutch and others that are commonly termed Domestic and which normally develop heads flat in shape and less compactly formed than those of the Danish type. The term also includes such varieties as Copenhagen, Glory of Enkhuizen, and others that develop heads roundish in shape but which in solidity of head and storage qualities are similar to the Flat Domestic type.

"Fairly firm" means that the heads yield slightly to pressure but are not soft.

"Well trimmed" means that the head shall have not more than four wrapper leaves attached and any portion of these leaves appreciably injured by worms or other means shall be removed, and the stem shall be not longer than one-half inch.

"Soft" means loosely formed or lacking compactness.

"Puffy" means that the heads are very light in weight in comparison to size and have air spaces in the central portion. They normally feel firm at time of harvesting but soften quickly. They are known as "Balloon Heads" in certain sections.

"Seed Stems" means those heads which have seed stalks showing or in which the formation of seed stalks has plainly begun.

"Free from damage" means that the head shall not be injured to an extent readily apparent upon examination.

INSPECTION*

"In July, 1920, there was established in California a commercial shipping-point inspection service carried on by the Bureau of Standardization, State Department of Agriculture. This service employs a corps of experienced, highly trained men who are authorized to inspect and certify to the exact quality and condition of the produce at time of packing and shipping. The demand for this service has increased steadily and its scope and importance has been greatly enlarged. Although such inspections were made only on request, between 2,000 and 3,000 cars of vegetables were inspected and certified during the fiscal year ending June 30, 1922. On July 1, 1922, this service was federalized, each inspector being deputized by the federal government, and certificates issued are now *prima facie* evidence in all courts of the United States."

"This inspection service is available in all of the leading vegetable producing sections in the state. The certificate shows the hour and date of inspection, inspection or shipping point, name and address of the shipper and consignee (when given), car initials and number, kind of car and its condition, if a refrigerator the amount of ice in the bunkers; the quantity of the products inspected; description of load and container; condition of pack; sizing, quality and condition of the products; color, grade, remarks. The buyer, therefore, knows the exact quality and condition of the product at the time the car is loaded, although he may be at a considerable distance from the shipping point. These shipping-point certificates are valuable to the grower as they protect his interests in the adjustment of claims or on a declining market. On the other hand, the buyer is assured that he will receive the quality of produce for which he has paid before seeing it. Whenever requested, a telegram giving the substance of an inspection will be sent "collect" to the buyer or any other interested party, so that the exact condition of a carload can be ascertained before the sale is even consummated."

INSECT AND DISEASE PESTS AND METHODS OF CONTROL

Cabbage root maggot.—It is during the larval stage that cabbage root maggot does its destructive work. The adult flies lay their eggs on the stem of the cabbage plant near the surface of the ground or on the soil in close proximity to the plant. The larvae are hatched within a few days, the length of time required for hatching depend-

* The Successful Marketing of California Vegetables. Special Publication No. 32. California State Department of Agriculture.

ing largely upon the temperature. The young larva migrate to the stem and roots below ground and there feed upon the epidermis and cortex and often burrow the entire system below ground. The larvae or maggots are white in color and about one-fourth inch in length when full grown. If the plant is badly infested it will wilt down and in the majority of cases does not recover. When the attack is light about the only evidence is the slowing up in the rate of growth of the plant.

As the root maggot infests many of the mustard crops, such as radishes, turnips, cauliflower, it is desirable to practice a rotation with crops not related to this group. Plow and work the soil during the late fall, winter and early spring to expose and destroy the pupae. Tarred paper disks have been used extensively to prevent the adult flies from depositing their eggs about the plant. The disks should be applied at transplanting time or at least before the flies start to deposit their eggs.

Corrosive sublimate has been used for some time in England for the control of this pest and within recent years has been put to experimental test in the United States and Canada. The first application must be made three or four days after transplanting; the second application nine or ten days after transplanting and the third application nineteen or twenty days after transplanting. Later applications should not be made because of the danger of poisoning the consumer. Dissolve one ounce of corrosive sublimate in a small amount of hot water, then add water sufficient to make 10 gallons. About the stem of each plant pour one-fourth teacup of this solution at each treatment. This material is corrosive, therefore should not be mixed in metal containers but in wooden barrels or earthen containers. The cost of each application is eight to ten dollars an acre. It will take approximately 200 gallons of solution an acre for each application.

Cabbage Aphis. — Cabbage aphis infestations are very general throughout the state, not only attacking cabbage but many of the related Brassicas. The aphis colonies are usually found on the under side of the older leaves and on the young succulent inner leaves. They lower the vitality of the plant by sucking out the juice and cause a curled and wrinkled appearance.

A good liquid spray for control of aphis is made up of the following:

Nicotine sulfate 40 per cent	1 pint
Fish oil soap	5 pounds
Water	100 gallons

An effort should be made to have spray reach the under side of the leaves and especially the central leaves.

A dust containing 5 per cent of 40 per cent nicotine sulfate has been found to give the most satisfactory and at the same time the

Fig. 8.—Cabbage affected by nematode worms.
(After L. L. Harter.)

most economical control. A good formula for making this dust is 95 pounds of hydrated lime plus 5 pounds of 40 per cent nicotine sulfate. Mixing should be thorough and only sufficient made for immediate use. On cabbage less than half grown about 30 pounds of dust an acre will be required, and on more mature plants about

50 pounds an acre. (For further information relative to dusting see Farmers' Bulletin No. 1282 and California Agricultural Experiment station Bulletin No. 336 and No. 357).

Cutworms.—In some sections, especially on land that has recently been in sod, the cutworms are a serious pest. They cut off the young plant near the surface of the ground, often destroying many plants. The best method of control is by the use of poisoned baits. The following formula is recommended.

Bran	25 pounds
White Arsenic	1 pound
Molasses (cheap blackstrap preferred)	2 quarts

Thoroughly mix the arsenic and dry bran. Dilute the molasses with a small amount of water and then mix with the bran into a moist mash. A barely moist mash is preferable to wet sloppy mash. Allow the mash to stand for several hours in order to give the bran an opportunity to take up the arsenic. Scatter the mash along the rows or near the base of the plants. It is best to make the application toward evening since the cutworms feed chiefly at night.

Nematodes.—The nematode, eel worm, or gall worm, as it is often termed, because of the gall-like growth it produces on the roots of plants, has not been reported as a very serious pest on the cabbage. The presence of this microscopic worm in the tissue of the root causes stimulation of growth in the vicinity of the parasite with resultant gall formation. Nematodes are seldom found in the heavier soil types but are prevalent in soils of a light sandy nature. Infected plants are retarded in growth and have a stunted appearance and when pulled up the roots have the characteristic knotty growths. Cereal and grass crops are resistant to the nematode and should be planted if the infestation is severe. Iron and Brabham varieties of cowpeas and velvet beans are almost entirely immune from nematode attack, and can be planted as a green manure crop if adapted to the locality in preference to other legumes that are more susceptible to nematode attack.

Extra care should be used to select a seed bed entirely free from nematodes. An entire field may become infested as a result of the plants becoming infested in the seed bed. Plants should not be imported from localities known to be badly infested with nematodes. Figure 8 shows the appearance of cabbage roots badly infested with nematodes.

Cabbage worm.—The cabbage worm is without doubt the most serious pest with which the cabbage grower in California has to

contend. Although it is easy to control, nevertheless the damage caused by this pest on the late summer and fall crops is tremendous. Arsenicals have proven to give the best control. There is a hesitancy on the part of some of the growers to apply lead arsenate or other arsenical sprays because of the possible danger to the consumer. Arsenicals, however, can be used as a control without danger of poisoning, as the cabbage head grows from the inside and all of the leaves that the spray can possibly reach are discarded in the field at time of cutting and trimming, and by the ultimate consumer in the final preparation for the table. As a result of this fear of using arsenical

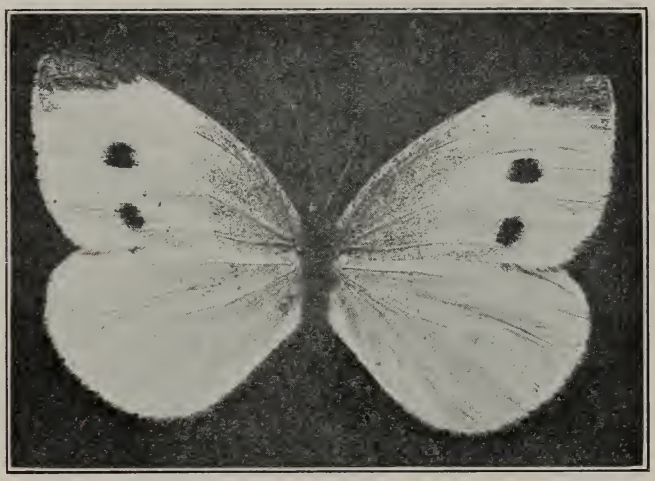

Fig. 9.—Female butterfly of the imported cabbage worm *Pontia rapae* (Linn) enlarged one and one-half times (after E. O. Essig).

sprays many other non-arsenical sprays and dusts have been used that have given little or no control, with consequent great loss to the grower. In young plants the larvae eat the succulent leaves and when the attack is severe often only a network of veins is left. In the older plant, after the head has started to form, the worms often bore into the head, ruining it for market. Some of the most serious infestations take place in the plant beds. Arsenicals can be applied in solution or as a dust. A recommended liquid spray is 1½ pounds of powdered lead arsenate, or 3 pounds of lead arsenate paste, to 50 gallons of water. In order to make the spray adhere and spread out in a thin film over the leaves, add 1 pound of common laundry soap to each 50 gallons of solution. The time to spray and number of applications to make depends entirely upon the infestation. Sometimes one or two sprayings at the proper time will be sufficient for

the entire season. Again, it may be necessary to spray every ten days or two weeks.

Excellent control can be obtained by dusting with a mixture of 1 pound of powdered lead arsenate and 8 to 10 pounds of air-slaked lime or gypsum (land plaster). The dust can be applied with a hand duster, by shaking through a burlap sack or a tin can perforated at one end. Dust should be applied early in the morning while the dew is still on the plants. Figure 9 shows a female specimen of the cabbage butterfly.

Diseases.—Many of the cabbage diseases so prevalent in the eastern and northern cabbage sections of the United States are of little concern to the cabbage growers in California. This is due, no doubt, largely to the fact that cabbage is produced during the fall, winter and early spring, when the temperature of soil and atmosphere is uniformly low.

Damping-off.—This is a seedling disease prevalent in the seed bed. The common symptom is a shriveling of the stem at the surface of the ground and the falling over and dying of the young plant. This damping-off may be caused by a number of different fungi and is most prevalent in seed beds that are crowded, damp and poorly ventilated. In attempting to control this disease preventive rather than curative measures should be used. Use new soil each year for the seed bed. The light, well drained, sandy loam soils are better than the heavier types. The surface of the bed should be stirred frequently to facilitate drying and air circulation. The bed should be located where it will get plenty of sunlight and good circulation of air. On cloudy days the beds should not be watered and on bright days sprinkle early in the morning. Frequent light waterings are less desirable than thorough wettings at longer intervals. If irrigation is practiced, the soil should be well stirred as soon as possible after each irrigation. Sow seed in rows far enough apart to allow a good air circulation about the plants and to permit the sun's rays to strike the soil.

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